

NESTING BIOLOGY OF THE BEE *MELISSODES* (*EUMELISSODES*) *MICROSTICTA* COCKERELL IN WASHINGTON STATE (HYMENOPTERA: APIDAE)

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Abstract.—*Melissodes microsticta* Cockerell nested gregariously in a vacant lot in Kitsap Co., western Washington from 1986–88 at least. Several other species of fossorial bees and wasps also nested at the site. *M. microsticta* was active during July and August and utilized the introduced composite, *Hypochaeris radicata* L., as a principal pollen source. Aspects of female diurnal activity based on 20 individual bees are analyzed. Females begin the day by foraging for pollen. No pollen is brought to the nest on the last trip of the day, which is presumably used to gather nectar. Eight to 12 pollen loads are collected per day, sufficient to provision one cell. The multicellular nests are described and illustrated. Cell depth ranged from 3.5–12 cm. Provision mass, egg placement, and larval feeding are similar to what has been reported for other *Melissodes*. The cocoon is described and illustrated. Parasitic bees, *Triepeolus* sp., were active at the nest site and frequently entered *M. microsticta* nests although no parasitized cells were recovered. The bee-hunting wasp, *Philanthus crabroniformis* Smith, was observed capturing a male *M. microsticta* on one occasion and unsuccessful attacks on males and females were observed.

Key Words.—Insecta, Hymenoptera, Apidae, *Melissodes*, nests, foraging, parasite, predator.

The bee genus *Melissodes* in North and Central America numbers about 100 species in eight subgenera (Hurd 1979). *Melissodes* are robust, hairy, medium-sized to moderately large bees capable of swift and powerful flight. It is probable that all *Melissodes* are solitary although communal nesting is known in *M. (Calimelissodes) composita* Tucker (Hurd & Linsley 1959) and in some species in the related genus *Svastra* (Rozen 1964, 1983). Studies of several species have shown that gregarious nesting is widespread in the genus (Thorp & Chemsak 1964, Clement 1973, Buchmann & Jones 1980, Triplett & Gittins 1988). Pollen use among species of *Melissodes* is variable. Many species in the subgenus *Melissodes* are polylectic (LaBerge 1956: 1117) whereas most species of *Eumelissodes* are oligoleges of the Compositae (LaBerge 1961: 402). LaBerge (1961) thought that certain *Melissodes*, because of their widespread occurrence, were of some importance as pollinators of crops including alfalfa and cotton. Parker (1981) showed that *M. (Eumelissodes) agilis* Cresson, an oligolege of *Helianthus*, could be a valuable pollinator of commercial sunflower while Triplett & Gittins (1988) felt that *M. (Melissodes) t. tepida* Cresson had some potential as a pollinator of forage and vegetable seed crops. Studies of several species of *Melissodes* have revealed a number of consistent behavioral features that led Cameron et al. (1996) to develop a generalized *Melissodes* life history based on their own and previous studies.

Melissodes (E.) microsticta Cockerell is a small, previously unstudied species from western North America. North to south it ranges from extreme southern Saskatchewan, Alberta, and British Columbia to southern California, Nevada, Utah, and Colorado, and northern Texas. West to east it occurs from the Pacific coast to north-central Texas and the eastern extremities of Colorado and Saskatchewan (LaBerge 1961). This paper presents information on the nesting biology,

foraging behavior, parasites and predators of *M. microsticta* based on the study of a population from the Puget Sound region of Washington State. The bulk of the observations were made during 1986 supplemented by brief observations the following two years.

MATERIALS AND METHODS

Observations of bees in the field were recorded with a portable microcassette recorder for later transcription. Times of various activities were noted to the nearest second using a digital watch. Nest locations were marked with color-coded, 15 cm long, bamboo skewers. Because bees usually left their nests abruptly, small cone traps made of aluminum window screen (Michener et al. 1955) were used to cover nests under observation and decrease the likelihood that nest enterings and departures would be missed. Cones were removed and replaced with as little disturbance to the bees and the nest site as possible.

Periodically during the day general observations of weather conditions were made noting sunshine, cloud cover, and estimated wind speed. At these times ambient shade air temperature was taken with a mercury thermometer. The thermometer was positioned 1 m above ground within 5 m of the nest site. At these same times temperature was also recorded at a location within the nesting site at a height 2 cm above ground for comparison.

Nest excavations were made using knives and trowels by following the main burrow, some of which were first poured with plaster of Paris. This worked best if the plaster was poured the day before excavation. Dry soil was wetted periodically with a spray bottle or eyedropper to assist excavation and help prevent soil from falling into cells. Nest measurements were made with a small ruler to the nearest 0.5 cm and sketches of nest structure and cell placement were drawn as a nest was excavated. Cell measurements were made with Vernier calipers to the nearest 0.1 mm.

Voucher specimens of *M. microsticta* and associated insects have been placed in the insect collection of Washington State University, Pullman, Washington.

RESULTS

Description of the nesting site.—*Melissodes microsticta* was studied in Kitsap County, Washington, 9.7 km north of Poulsbo. The nesting site was located in a vacant lot adjacent to the southern boundary of Kitsap Memorial State Park (Fig. 1). The western boundary of the lot dropped steeply down to the beach along Hood Canal (an arm of Puget Sound), its southern edge was adjacent to a residence, and a paved road lay to the east. Several large (ca. 10 m tall) conifers were present within the lot. The remaining vegetation consisted of grasses and forbs including a principle pollen source for *M. microsticta*, the introduced composite, *Hypochaeris radicata* Linnaeus, Hairy Cat's-ear or false dandelion. Hundreds of *H. radicata* plants grew in the vacant lot, and it was abundant along the roadside and in nearby lawns. Because the lot was mowed periodically and rainfall was slight during the bee's active season (July and August), most vegetation was less than 12 cm tall. Notable exceptions were the flowering stalks of *H. radicata*, which reached 30 cm in height. Within Kitsap Park to the north, vegetation consisted of mature conifers with a dense fringe of shrubs, especially Scot's broom (*Cytisus scoparius* (L.) Link) (Leguminosae), an introduced shrub.



Figure 1. View of *Melissodes microsticta* nesting site facing north (24 Jul 1988). Kitsap Park in background. Bees nested throughout much of lower half of area in photo. Many flowering stalks of *Hypochaeris radicata* visible.

The nesting area was located in the NW corner of the vacant lot, just south of the Kitsap Park boundary (Fig. 1), where the ground sloped gently to the south (less than 10°). Most nests were located within an area about $4\text{ m} \times 4\text{ m}$, but others occurred just outside this region and a few were observed at more distant locations within the lot. The total number of nests was estimated to be at least 250.

The vacant lot, approximately 0.1 ha, supported a diverse assemblage of ground-nesting Hymenoptera in addition to *M. microsticta*. The most numerous bee was *Lasioglossum zonulum* (Smith) (Halictidae), some nests of which were found within the *M. microsticta* colony although most occurred just to the east. There appeared to be more than 50 *Lasioglossum* nests. Nests of *Megachile perihirta* Cockerell (Megachilidae) were scattered around the lot. Nine were found during 1986, nine during 1987, and 14 during 1988. Three nests of *Andrena* (*Plastandrena*) *prunorum* Cockerell (Andrenidae) were located during 1988 and a single nest of a *Colletes* sp. (Colletidae) was found near the *M. microsticta* colony.

Nests of several solitary wasps (Sphecidae) were present also. The most abundant was a *Bembix* species, about 75 individuals of which formed a colony just to the south of the *M. microsticta* aggregation. Numerous bee-hunting wasps, *Philanthus crabroniformis* Smith, also nested in the area. A loose aggregation of nests occurred in the northeast corner of the lot, near the road, several nests were scattered within the *Bembix* colony, and others were dispersed around the site including at least one nest within the *M. microsticta*–*Lasioglossum* colonies. Both

bees were potential prey for the *Philanthus* (see below). Two nests of *Aphilanthops* sp. were located and the resident females observed on a number of occasions to return with winged ant prey. Finally, a single nest of an *Oxybelus* sp. was found.

The above bees and wasps in turn served as hosts for a varied group of parasites. These included a *Triepeolus* sp. (Apidae) parasitizing *M. microsticta*, *Coelioxys rufitarsis* Smith (Megachilidae) parasitizing *M. perihirta*, *Nomada* sp. (Apidae) on *A. prunorum*, and one or more *Sphecodes* (Halictidae) parasitizing *L. zonulum*. Cuckoo wasps (Chrysididae) and bee flies (Diptera: Bombyliidae) were common and likely parasitized some of the resident bees and wasps although no definite associations were made.

Seasonal Phenology.—The nesting site was first visited on 10 Jul 1986. Several male *M. microsticta* were observed on flower heads of *H. radicata* and it was suspected that the species might be nesting in the area. A brief visit seven days later confirmed it as a nesting site when a female returned to her nest with pollen within a few minutes. Twenty-five nests were located and marked on 21 and 22 Jul and on 23, 24, 29, 30, and 31 Jul observations were conducted starting between 09:00 h and 10:30 h PDST and ending between 16:30 h and 17:30 h PDST each day. Nesting activity probably began about 10 Jul and appeared to be at its peak during the second half of the month. Brief observations on 8 Aug showed that the *Melissodes* population was declining and *H. radicata* was past peak bloom, many flower heads having gone to seed. A few bees were still provisioning on 11 Aug but *H. radicata* was well past its prime. An active nest located on 14 Aug was excavated the following day, but it was apparent that few bees remained. Adult activity undoubtedly ceased before the end of the month.

Detailed observations of *M. microsticta* were not made during 1987 but the nesting site was active during the second half of July. Likewise during 1988 the *Melissodes* colony was active and bees were numerous. Blocks of soil from the nesting site were excavated on 31 Jul and 7 Oct 1988 to obtain cells for study, and judging from the number recovered, *M. microsticta* had had a favorable year.

General Activity of Bees and Flowers.—Similar weather conditions prevailed on each of the five 1986 observation days and were favorable for bee activity. Morning fog occurred some days but burned off before 12:00 h giving way to sunny, mild conditions with occasional, brief, cloudy periods. Winds remained calm. Daytime shade air temperatures reached highs of 18°–22° C. However, air temperature 2 cm above ground in the nesting site (usually in the sun) was considerably higher. For example, on 24 Jul at 09:24 h shade air temperature was 12.5° C whereas the corresponding reading at a height of 2 cm was 18.5° C in dappled sunlight. At 11:10 the temperatures were 14° C vs. 23° C and at 14:58 h the respective readings were 21.5° C and 40° C, the two highest temperatures recorded during the observations. Temperature near ground level was thus 5° C to 15° C higher than ambient shade air temperature during the period of maximum bee activity. The first *Melissodes* returning to their nests with pollen loads were observed between 10:05 h and 11:10 h each day and had thus been active for some time. Shade air temperature during this time was rather cool at 13° C to 15° C. The higher air temperature near the ground may have been important during initial flight activity among the *Melissodes*. Females were frequently seen prior to their first flights of the day either sitting in their nests with the head and thorax

exposed or making nest entrance repairs. Possibly the former individuals were basking to warm up. Flight activity among *Lasioglossum zonulum* usually appeared to be underway before that among the *M. microsticta* and the first *L. zonulum* females with pollen loads returned to their nests before the first *Melissodes* did so.

Flower heads of *Hypochaeris radicata* began to open as much as an hour before *M. microsticta* began to forage. This varied somewhat from day to day and flowers that came into the sun first were the first to open. Sun reached the *Melissodes* nesting area before much of the rest of the lot and flower heads there opened between 09:00 h and 10:00 h. Some *H. radicata* flower heads closed as early as 13:15 h and the majority closed by 16:30 h. *Melissodes* activity also began to drop off by mid-afternoon and had largely ceased by 17:00 h.

Male *M. microsticta* were seen during each 1986 visit. They flew about the nesting site and sipped nectar at *H. radicata*. Males occasionally pounced on females but were not seen to mate successfully. Most mating activity probably occurred prior to the observations of 23 to 31 July.

Diurnal Activity of Female Bees.—Twenty individual bees were observed on one or more of the five observation days for a total of 66 bee observation days. Three were observed on one day only but seven were observed on all five days. In 32 cases, the entire day's foraging activity was accounted for because the bees in question began activity (emerged into the cone trap for the first time) after observations began and returned to their nests and did not reappear before observations terminated for the day. The following pattern was observed in each instance. A bee initiated activity by foraging for pollen and gathered four to 15 successive loads. After each return, the bee spent several minutes (see below) within the nest during which time the principal activity was, presumably, the unloading of pollen from the scopae. The bee then left the nest on another foraging trip. After the final pollen-collecting trip of the day the bee spent an especially long period of time in the nest (see below). Her activities during this time can only be conjectured but may involve final preparation of the provision mass and oviposition. The bee then made another trip, but not for pollen as none was seen in the scopae upon her return. Such trips were assumed to have been for nectar collecting. After the nectaring trip the bee remained within the nest for the rest of the day.

The most frequent number of pollen collecting trips made in a day was eight, observed 10 times. Nine pollen trips in a day were observed five times, 10 trips—three times, 11 trips—five times, and 12 trips—four times. Four, 5, 6, 13, and 15 trips in a day were each observed once. Pollen foraging proceeded without interruption on a given day, and because nest excavations never indicated the presence of more than one open cell in a nest, it seems likely that all pollen collected on a given day goes into the provisioning of a single cell. The earliest a bee completed pollen foraging in the 32 cases was 13:08 h, the latest 1534 h. Bees not under observation returned with pollen after these times indicating that pollen was still available. The observed bees may have ceased foraging upon completing the provisioning of a cell. Eight to 12 pollen loads per cell may represent the number usually required. Occasional cells receive more, and some may receive fewer, although only four or five loads for a cell seems low. Such cells may have been partially provisioned the previous day.

Total time spent foraging for pollen (including stays within the nest between trips) averaged 222.9 min (± 47.68 ; $n = 32$). The shortest time was only 91 min (four loads collected) while the second shortest, 100 min, saw eight loads collected. The longest time was 324 min, during which 10 loads were collected. A complete day's activity for the same bee was obtained two days in a row on eight occasions and for one bee three complete days in a row were recorded. The amount of time required to collect the same number of pollen loads on different occasions by the same or different bees was variable. For instance, bee # 14 collected nine loads on both 30 and 31 Jul 1986 requiring 235 min the first day and 220 min the second. On the other hand, bee # 5 collected 11 loads in 215 min on 30 Jul but required 297 min for the same task the following day. Total foraging time for pollen and nectar averaged 317.97 min (± 45.23 ; $n = 32$) with a range of 200 min (four pollen loads, one nectar) to 421 min (10 pollen loads, one nectar).

Range in time required to collect a pollen load was 59–5399 sec (1313.76 ± 673.25 ; $n = 447$). The principal pollen source used by this aggregation of *M. microsticta* was the yellow, dandelion-like composite, *Hypochaeris radicata*, a very abundant plant in the vacant lot and surrounding lawns. Flight time to and from the pollen source was presumably minimal. The 59 second trip and a few others of similar duration seem very short and may be anomalous. LaBerge (1961) stated that this species is an oligolege of the compositae and listed several frequently visited genera. The bees under study here utilized one or more other, undetermined pollen sources since individuals occasionally returned with pollen loads a distinctly different color from *H. radicata*.

Range in time spent within the nest after a pollen foraging trip was 103–2509 sec (280.26 ± 251.63 ; $n = 400$). In contrast, stays in the nest after the day's final pollen collecting trip and prior to the nectaring trip averaged nearly 10 times longer at 2769.76 sec (± 703.92 ; 197–3851 sec; second shortest stay = 1730 sec; $n = 39$). The nectar collecting trip at the end of the day was 708–8926 sec long (3057.74 ± 1522.16 ; $n = 39$). Six times a bee apparently foraged only for nectar on a given day and completed one to four trips. These trips lasted 117–5635 sec (2723.07 ± 1622.94 ; $n = 14$).

Nest and Cell Structure.—The soil in which *M. microsticta* nested was very dry during the bee's 1986 active season as no rain had fallen in more than three weeks. Dead plant material and bits of charcoal were scattered thinly on the surface and living vegetation, mainly grass and *H. radicata* plants, was distributed as a sparse to moderately dense cover with areas of bare soil interspersed. The upper 2–3 cm of the soil was in many places loose and friable but below this it was more firmly packed. The soil was sandy but numerous pebbles ranging in size from a few mm to 3–4 cm were present. During some excavations very hard inclusions of variable size consisting of uniformly fine-grained particles were encountered. Plant roots reached cell level and below and the above combination of factors made nest excavations difficult.

Some nests entered the ground in areas of bare soil and were readily visible whereas others were concealed to varying degrees beneath the spreading, recumbent leaves of *H. radicata* plants. The nest entrance was not plugged with soil while a bee foraged. The form of the tumulus was variable. Some, especially those situated in areas of bare soil, consisted of a low, conical mound of loose

soil with the nest entrance centrally located. Others had the loose soil scattered to one side of the nest entrance as an irregularly shaped, elongate lobe. The latter were generally sited near the base of or beneath the leaves of *H. radicata* plants. Maximum dimension of a tumulus was up to 5 cm. Main burrows descended at angles from 45° below horizontal to near vertical (Figs. 2, 4 and 6) and most proceeded with numerous twists and turns (Figs. 2–7). Burrows were circular in cross section, about 5 mm in diameter, and had fairly rough walls. There was no evidence of a built-in soil lining.

The seven excavated nests contained seven to 11 cells each (Figs. 3 and 5) and some were still active on the day they were dug. Most nests contained a wide range of immature stages indicating rapid development. For example, the nest dug on 1 Aug 1986 had been active the previous day. It contained nine cells whose contents included eggs or small larvae, feeding larvae of variable size, and post-defecating larvae in cocoons. Nests were shallow with cells constructed at depths from 3.5–12.0 cm (7.9 ± 1.57 ; $n = 161$).

Cells were oriented with the long axis at an angle above the horizontal ranging from 45° to near vertical (Figs. 8 and 9). Cells were 10.0–13.6 mm in length (11.59 ± 1.04 ; $n = 8$), 5.6–6.2 mm in maximum diameter (5.93 ± 0.17 ; $n = 10$), and 4.3–4.9 mm in diameter at the closure (4.65 ± 0.16 ; $n = 12$). Cell walls were smooth and thinly coated with a waterproof material that prevented absorption of a drop of water for at least 30 minutes. The waterproofing did not extend much, if any, beyond the cell closure where the burrow walls were more roughly hewn than the cell walls. Occasionally the surface of one of the larger pebbles was incorporated into a cell's wall and a few cells were found that had been excavated in one of the hard soil inclusions. A thin layer of fine-grained soil (ca. 1 mm thick) appeared to have been used to fill in irregularities in the cell walls which, when finished, were smooth and even, with few of the coarse soil particles that were abundant in the soil generally. Addition of soil to the walls of an incipient cell and its tamping and smoothing with the pygidial plate has been described for the alkali bee, *Nomia melanderi* Cockerell (Halictidae) (Batra 1970) but should be confirmed for *M. microsticta* by direct observation.

The cell closure consists of a spiral arrangement of fine soil particles with about three rows to the radius and is concave on the cell-facing side. Integrity of the spiral is frequently lost at the center of the closure. The burrow outside the closure is tightly backfilled with soil after the cell is completed and closed.

Provision Mass and Immature Stages.—The provisions are deposited in the bottom of the cell, filling it to a depth of about 4 mm ($n = 3$). Provisions have a high nectar:pollen ratio giving them the consistency of a thin paste or gruel. A thin layer of more nearly pure liquid is present on the surface, perhaps due to the settling out of the pollen. A faint sourish odor, detectable from 3 or 4 cm away, was associated with the provision mass.

The white, translucent, shiny-surfaced egg measures approximately 3 mm in length and 0.5 mm in maximum diameter. It is slightly curved and sausage-shaped. The egg is placed on the surface of the provision mass with one end near the cell wall and the other near the center. Only the ends of the curved egg contact the provisions as its middle part rises above the surface of the mass.

The newly hatched larva lies on its side partly submerged in the provision mass and begins to feed. Detailed observations of feeding behavior were not made but

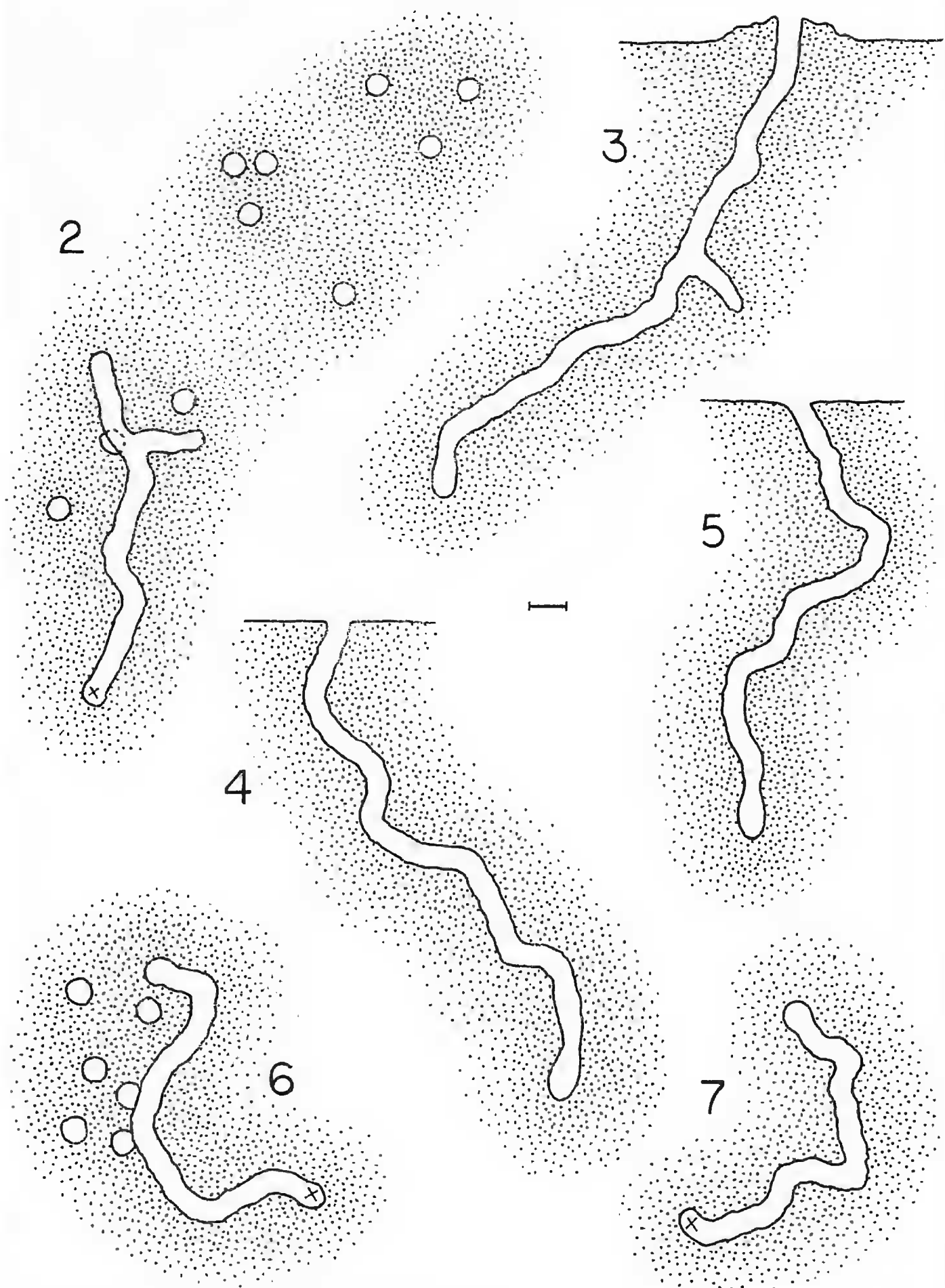


Figure 2-7. Nest structure of *Melissodes microsticta*.

Figures 3, 4, and 5. Vertical sections through main burrow and open cell of three *M. microsticta* nests.

Figures 2, 6, and 7. Horizontal plans of three *M. microsticta* nests showing main burrow and cell arrangement. X in Figures 2, 6, and 7 indicates entrance to nest at ground level.

Figures 2 & 3, 4 & 7, and 5 & 6 represent the same nest. Scale (= 1 cm) applies to all figures.

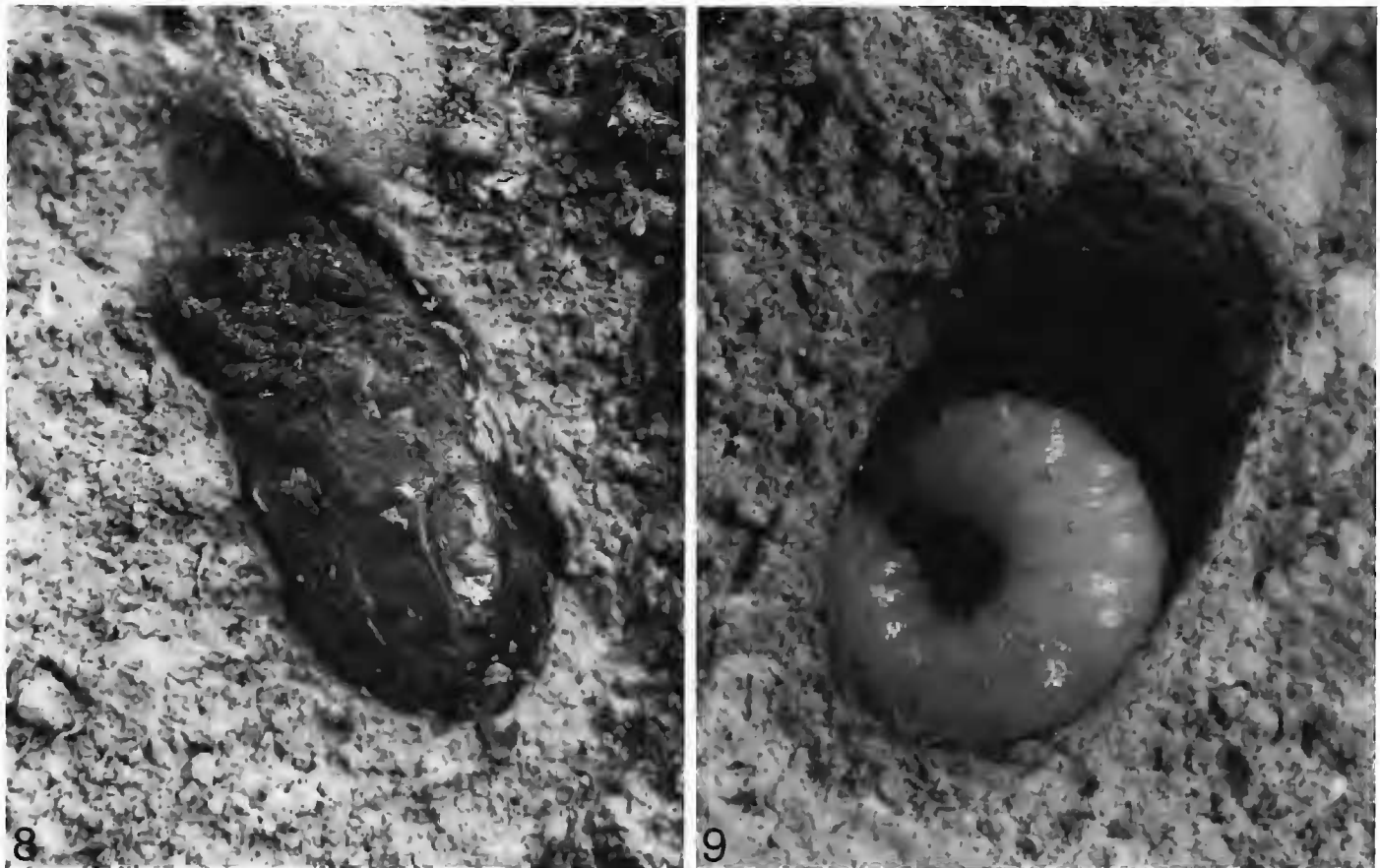


Figure 8–9. Cell, fecal deposit, cocoon, and larva of *Melissodes microsticta*.

Figure 8 (left). Longitudinal section through a cell of *M. microsticta* containing an intact cocoon. Fecal deposit visible above cocoon.

Figure 9 (right). Longitudinal section through cell and cocoon of *M. microsticta* showing post-defecating larva in situ. Fecal deposit visible above cocoon. Note steeply inclined long axis of both cells.

several feeding larvae of various sizes indicated that it is probably consistent with that observed in other eucerine bees such as *Melissodes* (*Melissodes*) *tepida tepida* Cresson (Triplett & Gittins 1992) and *Tetralonia hamata* Bradley (Miliczky 1985). Other eucerine larvae circle the cell as they feed, keeping the dorsal surface close to the cell wall. Eventually the provisions are reduced to an irregularly shaped mass around which the larva is tightly curled. The last of the provisions are then ingested.

Fecal material fills much of the upper part of the cell between the cell closure and the upper end of the cocoon (Figs. 8 and 9) and extends down the walls of the cell to varying degrees. In some cells feces reach the bottom and coat the cell walls almost completely whereas in others only a few strands extend down the cell walls and may not reach the bottom. In all cells, however, fecal material deposited along the cell walls is sandwiched between cocoon material applied to the cell wall prior to fecal deposition and cocoon material applied inside the feces after defecation is complete. The mature larva, overwintering within the cocoon, is thus isolated from the fecal deposit.

The cocoon is a fragile structure, easily torn or deformed. This is especially true of the lower part whereas the top is thicker and more rigid. The cocoon material is closely applied to the walls of the cell (except at the top) and its shape conforms to that of the cell. The cocoon is formed from at least two applications of silk as evidenced by the sandwiching of fecal material between layers of silk (see above). For the most part, however, it was not possible to separate the cocoon into two discrete layers. Only small pieces could be teased away intact and it

often appeared that more than two applications of silk had been made in a given area. The entire inner surface of the cocoon was smooth, uniform, and sheetlike. Under higher magnification, however, what appeared to be individual strands of silk were fused into the sheet. Just beneath the fecal material at the top of the cell separate strands of silk formed a thin, air-filled meshwork above the smooth, sheetlike inner cocoon layer. This part of the cocoon was noticeably thicker and more rigid than the rest of the structure.

Parasites and Predators.—A parasitic bee in the genus *Triepeolus* was frequently observed at the nesting site and displayed behavior characteristic of such insects. *Triepeolus* flew slowly through the nesting area and stopped to investigate nest entrances of *M. microsticta*. They frequently poked their heads into nests or entered them for brief periods. Dozens of such occurrences were observed but in no instance did a parasite remain in a nest longer than 30 seconds and most visits were much shorter. Whether the longer of such visits were of sufficient duration to accomplish oviposition is unknown. In any event, none of the more than 150 *Melissodes* cells examined during the study had been parasitized by *Triepeolus*.

Three *Triepeolus* were individually marked with a spot of paint on 23 Jul 1986 and two of them were spotted in the nesting area the next day. None were seen on 29, 30, or 31 Jul although other individuals were active on all three days.

One lengthy observation of parasite behavior around a *Melissodes* nest was noted on 31 Jul 1986. The parasite was spotted at 12:37 h and entered the nest for 24 sec at 12:38:06 h. During the next 27 minutes this parasite remained in the vicinity of the nest, usually less than 20 cm away, although she was lost for several seconds on three or four occasions. The *M. microsticta* returned with pollen at 12:40:32 h. The *Triepeolus*, which had been facing the nest while resting on a cone trap 7 cm away, flew to the nest and circled within 5 cm of it for 20 sec. It landed 3 cm from the entrance at 12:40:53 h. She soon changed position but remained in the vicinity until 12:59:04 h when she flew off. The *Melissodes* returned with pollen at 13:01:28 h having apparently left her nest unobserved. During these observations the *Triepeolus* changed position around the *Melissodes* nest 15 times and entered it on three occasions.

One other interesting interaction between host and parasite was recorded on 31 Jul 1986. A *Triepeolus*, under observation since 13:15 h, was hovering near a *Melissodes* nest just as the bee returned from a foraging trip. The bee flew directly at the parasite, striking it and knocking it to the ground. The *Melissodes* then entered her nest. Aggressive interactions between female *Melissodes* were never observed.

Bees are the most common prey of wasps in the genus *Philanthus* (Sphecidae), commonly known as bee-wolves (Bohart & Menke 1976: 561). *Philanthus crabroniformis* utilized a number of wild bee species as prey, but *Lasioglossum zonulum* served most frequently. A *Philanthus* was observed dragging a female *Lasioglossum* into her burrow on 22 Jul 1986. Capture of a *Lasioglossum* was recorded on 7 Aug 1986 and on at least 10 other occasions wasps were observed with *Lasioglossum* prey. *Philanthus crabroniformis* also hunted *M. microsticta* but less successfully. Capture of a male *Melissodes* was observed on 22 Jul 1986 and unsuccessful attacks on males were noted on two other occasions. Two unsuccessful attacks on female *M. microsticta* were observed. During one of these, brief contact between wasp and bee occurred. The rapid, powerful highly maneu-

verable flight of the *Melissodes* contrasted with the considerably slower flight of *L. zonulum* and probably made the former much more difficult targets for the wasps.

Two hunting tactics were observed by *P. crabroniformis*. Wasps flew slowly through the nesting site a few cm above the ground in an apparent search for victims. They also patrolled the *H. radicata* plants, flying rather slowly from flower head to flower head. If a potential victim was spotted on a flower head the wasp approached slowly at first then darted rapidly at the victim over the final several cm.

DISCUSSION

Many aspects of the nesting biology of *M. microsticta* were similar to what has been previously reported for other species in the genus and no marked differences between *M. microsticta* and other *Melissodes* with regard to a number of important behavioral and biological characteristics were brought to light. Cameron et al. (1996) recently provided an interesting discussion of a generalized *Melissodes* life history and most aspects of *M. microsticta* biology fall within the framework they outlined. The reader is referred to their paper for further details.

Pollen utilization by the *M. microsticta* population reported on here was interesting because the bees made use of the introduced composite, *H. radicata*. LaBerge (1961) classified *M. microsticta* as an oligolege of the Compositae and floral records available to him indicated that genera most often utilized in the Pacific Coast parts of its range were *Aster*, *Solidago*, *Erigeron*, *Gutierrezia*, and *Chrysothamnus*. Although an extensive search of the surrounding area was not conducted none of these genera, if present at all, was abundant. One native composite known to occur in the area was a species of *Grindelia*, gumplant, but it was not common. *Grindelia* is frequently visited by *M. microsticta* in the Utah-Wyoming area (LaBerge 1961). In contrast, *H. radicata* was abundant in the vacant lot and surrounding lawns and roadsides and is often common in disturbed ground in the Puget Sound region (Pojar & MacKinnon 1994). Its period of bloom coincided nicely with the adult active season of *M. microsticta*. The adaptability shown by *M. microsticta* in utilizing an abundant, but non-native species as a principal pollen source may well allow it to continue to exist, even thrive, in this urban area where native host plants are rare.

Isenberg et al. (1997) recently reported on an interesting feature of provisioning behavior in *M. (Eumelissodes) rustica* (Say). Individual *M. rustica*, after completing an average of six pollen foraging trips on a given day, made a final trip away from the nest but typically returned without pollen in the scopae. This trip was preceded by a stay in the nest significantly longer than those that preceded earlier pollen collecting trips. Bees returning from the final, non-pollen collecting trip had the crop packed with pollen and nectar whereas bees returning from earlier pollen collecting trips had little pollen in the crop. Isenberg et al. (1997) suggested that the large quantities of pollen and nectar ingested by *M. rustica* females on their final trips of the day were important for female self-maintenance, perhaps providing energy for ovarian stimulation and nest construction activities that take place during the night. Although crop contents were not examined in *M. microsticta* a pattern of foraging activity very similar to that in *M. rustica* was observed. *M. microsticta* females foraged for pollen early in the day, like *M.*

rustica, although the average number of pollen collecting trips was greater at 9.4. Also like its congener, *M. microsticta* females spent a considerably longer period of time in the nest after the last pollen foraging trip of the day than after earlier pollen foraging trips. At a mean of 46 min 10 sec these stays were about 10 times longer than earlier stays. Remarkably, *M. rustica* females spent almost exactly the same length of time within the nest prior to their final, non-pollen collecting trips: 46 min 5 sec (Isenberg et al. 1997). Such a close correspondence in observed above ground behavior between the 2 species may be related to similar within nest activities. Given the many similarities in nesting behavior reported for several other species of *Melissodes* a similar pattern of pollen and nectar foraging may be widespread within the genus.

Another interesting aspect of this study was the diverse assemblage of bees and wasps that nested in the vacant lot, potential competitors and even predator and prey sometimes nesting within a few cm of each other. Apparently all found conditions of vegetative cover, sun exposure, nesting substrate, and local availability of pollen sources and insect prey suitable to their individual needs and during the brief years of this study appeared to be doing well. Since the local area was largely residential or wooded, suitable nesting sites were probably limited. *Melissodes* generally do not nest in areas of dense vegetation such as urban lawns, preferring areas of bare ground or those with only sparse vegetative cover (Clement 1973, Buchmann & Jones 1980 for example) although *M. tepida* is an exception (Triplett & Gittins 1988). Nor are they known to nest within wooded areas. The relatively undisturbed habitat provided by the vacant lot, as it was not watered and only infrequently mowed, undoubtedly allowed several locally occurring species to establish and survive, at least in the short term. However, it is probably just a matter of time before the lot is developed at which time this interesting assemblage of insects will be lost.

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